METHODS AND APPARATUSES FOR FAST POWER CONTROL OF SIGNALS TRANSMITTED ON A MULTIPLE ACCESS CHANNEL

This application is a continuation of U.S. application Ser. No. 09/811,221, entitled "METHODS AND APPARATUSES FOR FAST POWER CONTROL OF SIGNALS TRANSMITTED ON A MULTIPLE ACCESS CHANNEL", filed Mar. 16, 2001, which is a continuation of U.S. application Ser. No. 09/113,721, now U.S. Pat. No. 6,275,478, all assigned to the assignee of the present application.

BACKGROUND

I. Field of the Invention

The present invention relates generally to mobile radio telephone systems. More particularly, the present invention relates to mobile radio telephone systems that control the output transmit power of information signals sent between mobile units and base stations. Even more particularly, the present invention relates to novel and improved systems and methods for quickly controlling the output transmit power of signals sent from mobile stations to base stations on multiple access channels within a mobile radio telephone system.

II. Description of the Related Art

In CDMA radio telephone systems operating in accordance with the TIA/EIA-95 standard (the IS-95 standard), the Access Channel (R-ACH) is used for communications from the mobile station to the base station when the mobile station is not assigned to a dedicated channel such as a Traffic Channel (TCH). The R-ACH carries originations, page responses, registrations, and acknowledgments to messages sent by the base station on the Paging Channel. The R-ACH is transmitted at a constant rate of 4800 bps. This is in contrast to the Traffic Channel which is variable rate. Details of an exemplary CDMA system can be found in U.S. Pat. No. 4,901,307 entitled "Spread Spectrum Multiple Access Communication System Using Satellite Or Terrestrial Repeaters", which is assigned to the assignee of the present invention and incorporated herein in its entirety by reference. The IS-95 standard is set forth in the TIA/EIA Interim Standard entitled "Mobile Station-Base Station Compatibility Standard for Dual-Mode Wideband Spread Spectrum Cellular System", TIA/EIA/IS-95, dated July, 1993, the contents of which are also incorporated herein by reference.

On the R-ACH, the mobile station uses a long code spreading mask that is specific to the base station. In particular, a base station can have up to seven Paging Channels. Associated with each Paging Channel is one or more R-ACHs (up to 32 are permitted). Each R-ACH has a long code mask which determines the spreading sequence. The mask includes the identity of the base station associated with the channel, the Paging Channel to which the R-ACH is associated, and the number of the R-ACH. This provides a unique long code mask and thus a unique long code sequence for the particular R-ACH.

While certainly possible, the R-ACH is not operated in soft handoff. This is unlike the Traffic Channel which is operated in soft handoff. Furthermore, the R-ACH does not have fast power control as on the IS-95 Traffic Channel. On the Traffic Channel, the base station transmits a power control stream at 800 bps to the mobile station. BPSK modulation is used for the power control bit stream. One phase of the bit indicates that the mobile station is to increase is transmit power; another phase of the bit indicates that the mobile station is to decrease its transmit power. The base station determines whether to have the mobile station increase or decrease its transmit power by controlling the received energy to noise density in the base station to a threshold. If the received energy to noise density is less than the threshold, the base station has the mobile station increase its transmit power; if the received energy to noise density is greater than the threshold, the base station has the mobile station decrease its transmit power. This is described more in IS-95 and in U.S. Pat. Nos. 5,056,109 and 5,265,119, both of which are entitled "Method and Apparatus for Controlling Transmission Power In A CDMA Cellular Telephone System" and assigned to the assignee of the present invention and incorporated by reference herein.

One reason for not having fast power control on the R-ACH is that multiple mobile stations may transmit on the same R-ACH, thus making it hard to control with one power control stream. Furthermore, if there are many power control streams controlling one channel, it is not clear how to map the power control stream to the mobile station. U.S. Pat. No. 5,604,730 which is assigned to the assignee of the present invention describes how one power control stream can be used to control a number of mobile stations. As described below, the technique taught in this patent is also applicable to the invention described herein.

In CDMA systems operating in accordance with the IS-95 standard, the mobile station determines a level at which to transmit on the R-ACH based upon an open loop power control estimate, adjusted by some overhead parameters. More particularly, under the IS-95 standard, the mobile station attempts an access on a R-ACH by sending one or more access probes. An access probe is the message which the mobile station is trying to send to the base station. The mobile station starts by sending an access probe; if the mobile station does not receive an acknowledgment to this access probe, the mobile station increases its transmit power (by a value given in the overhead messages) and sends the probe again. This continues until the mobile station receives an acknowledgment or the mobile station has reached the limit of access probes which are permitted.

In any multi-access system, one key aspect of system design is congestion control. From the perspective of the R-ACH, congestion control is responsible for controlling the number of mobile stations simultaneously accessing a R-ACH. Congestion control is important since when too many mobile stations access the system, the system is unable to handle them. Specifically, there can be more transmissions on the reverse link than the base station is able to receive. This is a physical hardware limit. Secondly, the reverse CDMA channel has a capacity limit. When the capacity limit is reached, then the required transmit power of the mobile stations goes to infinity-thus, not permitting communications. Thus, it is necessary to keep the load on the channel within limits. Since the R-ACHs typically share the reverse channel with traffic channels, a certain fraction of the reverse capacity is typically allocated to the R-ACHs. It should be noted that excessive loading on the R-ACHs can create a substantial load on the reverse link, thus limiting the performance of mobile stations which are already assigned to a Traffic Channel. It should also be noted that the R-ACH itself is somewhat unstable as the actual throughput of the R-ACH may decrease after a certain load is reached on the reverse link. In order to control this load, the IS-95 standard has a number of congestion control mechanisms. These include access probe backoffs, access sequence backoffs, channel randomizations, and PN randomizations. However, IS-95 lacks any mechanism for quickly enabling and disabling access to a R-ACH in order to control congestion.